

AMERICAN  
**RAILROAD JOURNAL,**  
AND  
**MECHANICS' MAGAZINE.**

No. 3, Vol. VIII.]  
New Series.

FEBRUARY 1, 1842.

[Whole No. 399.  
Vol. XIV.]

[For the American Railroad Journal and Mechanic's Magazine.]

PHILADELPHIA, *January 4, 1842.*

GENTLEMEN: Will you do me the favor to publish in your Journal my little pamphlet on "The Causes which have Conduced to the Failure of many Railroads in the United States," which is reviewed in your last number. ✓

I would much rather that a knowledge of the principles which I advocate should be obtained from the pamphlet, as they are expressed in my own language, than from the version given by your correspondent.

Errors so palpable as those which I appear to have committed, could not do much harm before an intelligent community, under any circumstances; and now that they have been so ably met and so clearly exposed, by a logical and accurate writer, they may be read without the least danger to established practices.

You deal unfairly by me, in charging my views to inconsiderate haste, or confined observation. They are attributable to neither. They were formed long ago, and have been published before. Observation, study and intercourse with gentlemen who originally differed with me in sentiment, have not convinced me of my error. I have, for years, advocated, in writing and conversation, as correct maxims,

I. That railroads should be made with a proper regard to the business which they are intended to accommodate.

That strong roads and easy grades are appropriate for a heavy

trade, and weaker and less costly roads, and steeper grades, should be adopted for a light trade. The *measure* of strength and the limit of steepness, being determined by the *amount* of the anticipated trade.

II. That a single track is sufficient in almost all cases.

III. That high velocities may be adopted for the conveyance of travellers, but that a very slow motion (five or six miles per hour) should limit the speed of transportation of heavy produce.

IV. That light engines, running on a cheap road, should be employed for the accommodation of a very small business, and powerful ones on a strong and heavy road, should be adopted for a very large business.

V. That small and light cars should be used for the small trade, and the conveyance of very few travellers, and larger, and stronger, and heavier ones where the business is sufficient to fill them, and authorise a road substantial enough to bear them.

VI. That the tariff of toll should be adapted to the ability of the articles, and subject to the laws which govern trade.

The pamphlet which you condemn aims to support some of these general maxims.

"Let Truth and Falsehood grapple." If my views be not sustained by common sense and an extensive experience, railroad companies will still continue to make large roads, and provide great power, and expend vast capital, for the transportation of a small trade. If, on the contrary, my suggestions be prudent and sensible, in course of time they will receive the sanction of public opinion.

Respectfully yours,

CHARLES ELLET, JR.

In introducing the criticism upon Mr. Ellet's pamphlet, in the last number of this Journal, it was remarked that we considered that it required immediate notice, our arrangements at the time did not admit of the insertion of the entire pamphlet, and we felt less anxious about doing so, presuming it to have been freely circulated among the profession. The idea of doing injustice to any one was far from us, and we least of all contemplated such wrong toward Mr. Ellet. The same reasons which have impelled him to write the paper, have compelled us to enter a caveat against what we conceive to be injurious to the cause in which we labor in common.

In the foregoing communication, the chief points insisted upon in the pamphlet are fairly propounded. We propose to make an examination of them for the sake of convenience, rather than refer to the extended paper which we give in full in this number. In

so doing, we hope to be able to show wherein we differ from the writer and where we agree, thus narrowing the question down to the true issue, and affording a better opportunity of comparing the conflicting views.

"I. That railroads should be made with a proper regard to the business which they are intended to accommodate."

We give entire consent to this proposition, but there remains a question as to what this "proper regard" may be. The explanation which accompanies it, is open to the same question, and the latter clause is not such as we could agree to, without much qualification. The consideration of this point is incorporated with that of several others, and is given in the same place.

"II. That a single track is sufficient in almost all cases."

This is precisely in accordance with our views, and has been generally practised upon by the profession—very few roads having entire double tracks, and although graded for them in most cases, the additional width is not more than is actually required for a good and sufficient drainage, and the convenience of turn-outs, wherever they may be required.

"III. That high velocities may be adopted for the conveyance of travellers, but that a very slow motion (five or six miles per hour) should limit the speed for the transportation of heavy produce."

The only objection to this is the very slow motion assigned as the proper limit for transportation, we would rather say eight to ten miles per hour. The views of Mr. Ellet are, however, consistent in this respect, and his rate of five to six miles is a necessary result of his other positions.

"IV. That light engines, running on a cheap road, should be employed for the accommodation of a very small business, and powerful ones on a strong and heavy road, should be adopted for a very large business."

"V. That small and light cars should be used for the small trade, and the conveyance of very few travellers, and larger, and stronger, and heavier ones where the business is sufficient to fill them, and authorise a road substantial enough to bear them."

These two propositions are in intimate connection with each other, and must be noticed together.

The sixth proposition is one upon which all parties are unanimous.

The peculiar points of Mr. Ellet's views, upon which a difference exists, may be thus summed up:—

That the strength of the road, and consequently its cost—the

weight and power of the engines, and the weight and strength of the cars are to be in exact proportion to the amount of the trade. At first sight, it may appear that these are mere truisms, and in a vague and general sense, they are such, but when we descend to their particular application, we find that there is a wide room for discussion.

In the first place, if correct in every other respect, these propositions will not hold good in a young and growing country. Every railroad that has been built in long settled countries, when properly conducted, has produced an increase of traffic upon the line. How then will it answer in a population increasing ten to fifteen per cent. in ten years, to limit the capacity of the work to the actual traffic, when all experience has proved that with a fixed population, a great increase must be expected? This is the true question,—by what estimate of traffic shall we determine the standard which is to regulate the power and capacity of the road and its machinery? If we take the actual and existing traffic, we shall then be prepared to give a more full assent to the correctness of Mr. Ellet's assigned cause of the failure of railroads. But can we, with any propriety, take such narrow views without at once diminishing the benefits of railroads in such a manner and to such a degree, as to deprive us of one of the most powerful motives to their construction.

It may be answered, that it is easy to reconstruct a road, and enlarge its capacity to any extent. But this is not the fact. When once the land along a line has been purchased, and the road is in operation, all property in its vicinity rises in value, and any additional purchase by the company must be made at an enormously increased price. Here certainly any economical advantage contemplated must be defeated. In like manner, a heavier rail cannot be substituted for a lighter one, without an increase of expense far exceeding the capital consumed in using from the first a heavy rail, together with the interest upon it. To counterbalance this, we have the transportation of the original rail to and from the ground, together with its depreciation in value.

The wood work being of a more perishable nature, and the machinery being locomotive, changes may be more easily effected, yet even here the advantages must be very small.

We must remember that the infant railroad is to be clothed in an iron suit, which can neither be altered nor stretched,—if we give him a tight fit at once, he never can grow any larger, and if we desire his future welfare, we must at first allow him some spare room.

But there is another view in which railroads of inferior capacity



may be regarded as positive evils. Let us suppose a company of moderate capital to construct a cheap road between two cities, and that the capacity of this road is strictly limited to the actual traffic. Soon a vast increase of business accrues, as might have been expected, both from the growing state of the country and from the facilities offered by the railroad itself. But the company have not the means of increasing the accommodation, and do not desire it, as they have an ample return for their capital, and have the means of influencing prices and in fact of doing what they please, as they need not carry all the passengers, and having the advantage, can charge high fares. No other railroad company and no other means of conveyance would willingly enter into competition under such circumstances, and we have finally a downright monopoly of the most odious kind. We can form some idea of such a state of affairs by our own State works. The canal is deemed insufficient for the traffic, but the railroads are not allowed to carry freight, therefore the canal must be enlarged at an expense sufficient to construct a railroad of the most permanent character from New York to Buffalo, by the way of Albany and the Mohawk valley, and by the route of the Erie railroad. The causes are not exactly the same, but the effect is.

But if we attempt to make the traffic the *exact* measure of the strength and capacity of the road and its machinery, we find that in descending, a limit is soon reached at which the railroad possesses scarcely any advantage over a common road,—and yet under the same circumstances, an increased capacity would give it a decided advantage for speed and certainty over all other modes of communication. Thus, a substantial railway between two places not far distant, and with moderate business, might obtain the freighting and travel between the two, and even by its regularity and dispatch, do away with nearly all traffic by private conveyances, and actually induce persons to travel who did not before. But if a cheap road and inferior machinery were adopted, no such advantages could be held out, and rival modes of conveyance would increase, and in a corresponding degree would the business of the railway decrease with any decrease of expense. This is not imaginary, for we have seen a case in point,—the railroad was good, but the machinery inferior, and the management on the cheap system. Not one, but several stage lines were supported, and one parallel with the road, and in winter, with bad roads, averaging about the same time with the railroad cars, and sometimes actually passing them on the way. A railroad must absorb all the traffic,

and to do this, must be substantial in its structure and liberal in accommodations.

In the same manner, the rate of carrying freight exercises an important influence—a speed of from eight to ten miles per hour, puts at distance all other rivals, while one of five to six is so little better than the transit by common roads, that not much is to be gained. On a weak and inferior road, freight can only be carried at a low rate of speed, and even then, more injury is likely to be done to the structure than heavier weights and higher velocities on a stronger road.

The proposal to employ cars varying in size and strength with the traffic is most singular, whether we regard its reference to economy, to safety, or to popular prejudices. This would be like regulating the thickness of the plank by the tonnage of the vessel in exact proportions. We are far from supposing that Mr. Ellet contemplated any such ridiculous extension of this proposition, yet there can be no doubt that the tendency of such a doctrine would be to injure the capitalists, and excite the prejudice of the travelling community. It would be far better to regulate the number, rather than the size and strength of the cars.

There is one consideration which has a powerful influence in determining this question. The travel on railroads as well as by all other modes of conveyance, is not uniform throughout the year—that of a few summer months being frequently several times greater than the average for the year. Now in such cases, unless the tide of travel is taken, and all of it taken at its flood, but little profit will result. Hence a provision must be made to meet the utmost demands; and this can only be accomplished at the expense of an establishment throughout fitted to the greatest emergency.

That a due regard should be paid to the extent and nature of the traffic, no one will dispute, but that any constant proportion should prevail, is not easy to be proved, even if we could decide upon the exact amount of traffic—in itself a matter of much uncertainty and liable to great fluctuations. Moreover, the experience of the past has shown, in many instances, that inferior capacity of the road and inadequate accommodation have been the cause of want of success, rather than that the other extreme had been reached.

In speaking of the capacity of the road, we have included character of grades, strength, structure and size, and power of locomotive and machinery. A few remarks may apply to these separately. The strength of the road and the weight of the rail must remain fixed, but the power of the engines may vary, though within much narrower limits than those proposed by Mr. E.; in the outset they

may be of more moderate size and force than afterwards. There is a great advantage in having a strong structure even for lighter engines, as the efficiency of the latter depends much upon the former—an incipient traffic may be conducted more economically upon a heavy rail and structure, than upon one weak in proportion to the size of the engines.

Our doctrine then may be summed up thus:—

That roads should be constructed with a reference to the accommodation of the greatest amount of traffic likely to accrue, either by increase of population or by the advantages offered by railroad transportation. That the grades and strength of structure should be regulated according to the nature and direction of the greatest traffic (whether passage or freight, and whether up or down) and calculated to have rather an excess than a mere sufficiency of strength. That in the beginning, a smaller number of engines and cars may be used, and that, as a general rule, the number, rather than the strength, both for cars and engines, should be regulated according to the amount of business.

Lastly. That in everything, expedition, strength and safety, should be provided for, and that nothing should be considered costly that was absolutely necessary to them, and that nothing should be considered cheap, that did not fully satisfy the demand in all these respects.

*Statements showing the amount of different articles shipped southward upon the Susquehanna Tide-water canal, during the year ending November 30, 1841.*

Flour, barrels,	71,471
Wheat, bushels,	550,391
Other grains, "	196,780
Salt pork, barrels,	399
Bacon, pounds,	494,691
Butter and cheese, pounds,	384,648
Fish, barrels,	60
Sundries, pounds,	3,115,000
Rags, "	213,800
Cotton, "	197,442
Tobacco, "	2,086,064
Leather, "	262,366
Mineral coal, tons,	33,250
Iron ore, "	1,894
Iron, pig castings, tons,	18,753
Lime, bushels,	58,507

Limestone, bushels,	54,06
Sawed timber, feet,	6,011,779
Staves, shingles, headings, etc.	2,150,410

*Statement showing the amount of articles shipped northward on the Susquehanna Tide-water canal during the year ending November 30, 1841.*

Dry goods, pounds,	1,627,599
Groceries, " "	9,129,975
Hardware, " "	920,825
Queensware, " "	611,140
Sundries, " "	5,098,160
Plaster, tons,	8,338
Nails, kegs,	1,371
Salt, bushels,	78,013
Fish, barrels,	16,000
Shingles, number,	81,000
Lumber, feet,	29,395

Amount of tons shipped southward,	88,800	Tolls, \$49,222
" " " northward,	20,600	" 21,045
Tons,	109,400	\$70,267

The above shows a considerable increase of trade over the preceding season. A full two-thirds of this trade was carried to and from Philadelphia by steam towage, and the balance to Baltimore.

**PENNSYLVANIA PUBLIC WORKS AND FINANCES: From GOVERNOR PORTER's Message.**

The subject of deepest interest, and greatest perplexity, that calls our attention, is the financial condition of the State. Although I have, on several former occasions, entered into a full and minute exposition of this matter, I cannot refrain from again presenting it to your consideration, in a manner so distinct and plain, as to preclude, I trust, the possibility of misconception on the part of those who feel an honest desire to understand it. I am persuaded that however embarrassed may be the pecuniary affairs of the commonwealth, nothing is needed to induce the people to provide means to extricate them, but a clear and candid exposition of the nature and extent of the liabilities to which they are subject. The time for concealment, evasion and deception on this point, is at an end. The contract has been made: The faith of the State is pledged, and every consideration of duty and of honor require of us, to know



our true condition, and to provide adequate means to meet our obligations, and to redeem our plighted faith.

There is due by this State to the United States, on account of deposits of the surplus revenue, the sum of \$2,867,514 78. The funded debt of the State, amounts to \$36,331,005 68. The debt is reimbursable as follows:—

1841	6270,081 87
1844	62,500 00
1846	3,516,568 81
1847	50,000 00
1850	1,000,000 00
1853	2,000,000 00
1854	3,000,000 00
1856	2,783,161 00
1858	7,070,161 00
1859	1,250,000 00
1860	2,648,080 00
1861	120,008 00
1862	3,225,000 00
1863	200,000 00
1864	2,515,000 00
1865	1,797,010 00
1868	2,524,000 00
1870	1,957,362 06
At the expiration of certain bank charters,	340,981 00

Total, \$36,331,005 68

This debt has been contracted for the following purposes:—

For canals and railways,	\$30,055,013 68
To pay interest on public debt,	3,304,303 00
For the use of the treasury,	1,581,689 00
“ Turnpikes, State roads, bridges, etc.,	930,000 00
“ The Union canal,	200,000 00
“ “ Eastern penitentiary	120,000 00
“ “ Franklin railroad,	100,000 00
“ “ Pennsylvania and Ohio canal,	50,000 00

Total, \$36,331,005 78

The value of our public improvements, estimated at cost, is \$29,292,165 33

The State owns bank stock which cost, at par 2,108,700 00

“ “ “ Turnpike and bridge stock, 2,843,048 89

“ “ “ Canal and navigation stock, 831,778 66

“ “ “ Railroad stock, 350,546 90

Money due on unpatented lands, estimated at 1,000,000 00

Total \$36,426,239 78

The immediate difficulty of our situation, arises mainly from the payment of the interest annually accruing on this debt. This interest is about \$1,800,000; and this sum, it is incumbent on the

State to provide as it becomes due. The inconsiderable portion of the funded debt, now redeemable, can be, doubtless, postponed until more auspicious times, but the interest admits of no such postponement. This is in a great measure payable to those who cannot afford to procrastinate its reception, and whose means of substance depend on the faithful adherence of the State to its solemn engagements with its loan holders. The income especially appropriated to the payment of this interest, is derived from the following sources, to wit:—tolls on canals and railways, auction duties, tax on collateral inheritances, dividends on turnpike, bridge and navigation stocks, escheats and the tax levied on real and personal property, etc. The amount received from each of these several sources, during the last fiscal year, ending 30th November last, is as follows:—

From tolls on canals and railways,	-	-	\$762,360	44
" Auction duties,	-	-	77,022	15
" Collateral inheritances,	-	-	21,591	43
" Dividends on turnpike, bridge and navigation stocks,	-	-	30,355	72
" Escheats,	-	-	336	64
" Tax on real and personal property, etc.	-	-	33,292	77
<b>Total,</b>	-	-	<b>\$924,959</b>	<b>15</b>

The sum in the treasury, applicable to this object, on the first day of this month, independent of what will be received during the month, was \$1,020,936 38, being \$124,042 62 more than is necessary to pay the interest due on the first of February next.

These internal improvements, for the construction of which the principal amount of the State debt has been incurred, consists of 768½ miles of canal and railways completed, and 165½ miles of canal in progress of construction and nearly completed.

The finished works are the following:—

	Miles.
The Delaware canal, from Easton to tide at Bristol,	59½
The main line of canal and railway from Philadelphia to Pittsburgh,	395½
Canal from Beaver, on the Ohio river, to Greenville, in the direction of Erie,	72½
Canal from Franklin, on the Alleghany river, to Conneaut lake,	49½
Canal, Susquehanna and North branch, from Duncan's island to Lackawanna,	111½
Canal, West branch from Northumberland to Farrandsville,	73
Several side cuts and navigable feeders,	7
<b>Total canals and railways completed,</b>	<b>768½</b>

Canals in progress and nearly completed:—

	Miles.
North branch extensions, from Lackawanna to New York line,	90
Erie extension, from Greenville to Erie harbor,	62½
Wiconissco canal, from Duncan's island to Wiconissco creek,	12½
<b>Total canals in progress,</b>	<b>165½</b>

The report of the Canal Commissioners, with the accompanying documents, which will shortly be laid before you, will show in detail, the state and condition of our public improvements. Having in former communications to the legislature, stated my views in relation to our system of internal improvements, I beg leave respectfully to refer you to them, as being unchanged, without wishing unnecessarily to extend this communication, by embodying them in it.

When I first entered upon the duties of the executive department, the question of completing the North branch and Erie extensions was submitted to the action of the legislature. The representatives of the people decided in favor of completing both, and have, by three subsequent acts, appropriated considerable sums of money for that purpose. The North branch canal has already cost \$2,348,276 38, of which the sum of \$389,676 42 remains yet due to contractors. The Erie extension has already cost about \$2,919,507, of which the sum of \$574,406 23, is yet due to contractors. The grave question is now presented to your serious consideration, whether, under all the circumstances, those two lines are to be forthwith finished, or abandoned for all time to come, and the entire amount of labor and money expended upon them thrown away. Contractors who have gone on to the work, and perhaps executed the least profitable part of it, will have fair claims on the justice of the legislature for remuneration, for the losses they have sustained by an abandonment of the work by the Commonwealth. Judging from the success which usually crowns perseverance in similar applications before the legislature, there can be little doubt that this class of claimants will not go away unanswered and unsatisfied. The farmer, whose lands have been cut up and destroyed, will also be a just claimant for compensation for the injury he has sustained, for which the advantages from the proposed canal will not be an available set off; and it may be well to inquire whether the amount of those claims would not go far towards the completion of those branches of our improvements. The only valid objection to a prosecution of these works to completion, is the difficulty to be apprehended in raising the necessary funds for the purpose. The estimated cost to complete the Erie extension, is \$536,142 46, and the North branch, \$1,298,416, independent of the arrearages due contractors, as before stated, which must be paid at all events. More confidence can be placed in the accuracy of these estimates of the cost of completing these works, than could be extended to those made in the early stages of our public improvements, from the increased practical experience of those intrusted with the duty of making them. My own opinion remains unchanged, that it is our true policy to go on and complete both these works with as little delay as possible. This, however, is a question exclusively for your decision.

For the debts now due to contractors on these lines, as well as for repairs on the other lines rendered indispensable, and without which many portions of our canals would have been unavailable

and useless throughout the season, I respectfully urge that some prompt and immediate provision be made. Many of the contractors have laid out their money for a long time, and have suffered serious injuries by the delay. If no better expedient can be devised, I would recommend the immediate issuing of a six per cent. stock, to all such creditors, redeemable at such time as shall be thought most expedient.

The amount required to pay debts due for repairs on the several lines of canal and railroad, it will be observed by the report of the Canal Commissioners, is unusually large. This is to be ascribed to the unprecedented breach which occurred in the Delaware division, in January last, which cost about \$150,000; to the renewal of the north track of the Columbia railroad, to the rebuilding, in a permanent manner, the locks, bridges and aqueducts on several of the divisions, and particularly on the North branch, where the original superstructures, composed entirely of wood, had so far decayed as to leave no other alternative; than either to renew them throughout, or abandon the navigation entirely. It is also, in part, to be ascribed to the fact that only a portion of the funds appropriated by the act of the 4th of May last, for repairs, and to pay the debts then due, became available, leaving a large balance of the appropriations for these objects, therein authorized, still due to the public creditors.

There is always, even under the most economical administrations of affairs, a greater amount of expense incurred in managing and keeping in repair great public improvements for the Commonwealth, than it would cost if they were in the hands of individuals. It is, therefore, respectfully suggested for the consideration of the legislature, whether the public interest would not be promoted, and the amount of State debt considerably lessened, by a sale of the canals and railroads belonging to the Commonwealth, or at least, a portion of them, or such other disposition as would diminish their annual expenses to the Commonwealth, and increase the amount of revenue from them.

Were the Commonwealth free from debt, I should hesitate to recommend the sales of any of her public improvements. But oppressed as she is, the cost which the repairs require, and the necessity of relieving ourselves as far as possible, induce me to urge action on this subject, at least so far as regards the Columbia railroad and the Delaware division of the Pennsylvania canal. It will matter but little to those interested in the use of the improvements, whether they are in the hands of the public or of individuals, provided proper safeguards are enacted to protect the public in the free use and enjoyment of them, and to guard against abuses and exactions. It may be objected that sales cannot be effected in the present state of our pecuniary embarrassments, that will be no reason why a law should not now be enacted authorising the sale of such portions of them as shall be deemed proper, subject to the approbation of the legislature on the sale being reported. If sold, even on an extended credit, if the principal be secured, and the interest punctually paid, it will so far relieve the Commonwealth. If it were made a condition that State stock should be received in payment, it would prob-



ably make the sale more advantageous to the Commonwealth. The disposition of capitalists would thus be made known, and it can, at least, be ascertained whether a sale at an adequate price can be effected. The policy of leasing for a term of years, one or both of those improvements, has been more than once suggested. Of the propriety of so doing, I am not prepared to express a decided opinion, but have thought it worthy of a suggestion for your consideration.

That the public works should be unproductive, is owing in a great measure to a want of proper legislation on the subject, and unless this be remedied, it must impair public confidence in their ultimate utility. The Canal Commissioners have repeatedly urged upon the legislature the propriety of allowing the Commonwealth, alone, to carry the passengers on the Columbia railroad. No railroad in the United States could sustain itself, if it were to relinquish the carrying of passengers, yet on that road this strange condition of things is exhibited. The State has expended in its construction over four millions of dollars, where the capital employed by those carrying the passengers, is perhaps thirty thousand dollars. The State, on her immense outlay, is reaping about three per cent., while the individual carriers on their thirty thousand dollars, are clearing nearly two hundred per cent. So it is also with regard to the transportation between Philadelphia and Pittsburg. That line of our improvement between those cities, was constructed at a cost of a fraction over fourteen millions of dollars. The transportation on it is monopolized by some seven or eight companies, employing a capital of less than four hundred thousand dollars; yet, while the State is receiving little more than will keep it in repair, the transporters are realizing immense profits, and that too, on a comparatively small outlay.

This can only be remedied by vesting the Canal Commissioners with full and ample authority to adopt such measures, as in their judgment, will be best calculated to enlist individual enterprise, and invite competition, and to counteract the effects of the selfish and monopolising system that has controlled, and now controls, the transportation on our public works.

It may possibly be supposed that the Canal Commissioners possess adequate power already for this purpose, but this is to mistake the case. From the nature of that department of the government, it is always made the target at which the discontented and interested point their shafts. Not a session of the legislature passes without harassing the commissioners with investigations,—the whole State is ransacked for accusers,—every act is questioned and misrepresented, and after all, the result is fruitless. The first instance is yet to be found, in which any thing tangible has been produced, or any salutary reform of the system effected. Were the legislature to devote one session to an honest and thorough examination and correction of the abuses and defects of the system, without annoying and pursuing individuals for sinister ends not openly avowed, much good would be produced; but, under any other mode of treating this subject, the issue must be as idle and frivolous as heretofore. I do not wish to preclude the most searching investigation. I merely desire

to direct your attention in a channel that will be beneficial to the public.

One of the greatest evils of these frequent and frivolous investigations is, that they bring legislative investigations themselves into discredit. The persecution of the innocent, always furnishes a shield to the guilty.

It is now, throughout the country, a matter of idle sport to talk of these investigations. The mode by which they are brought about is well understood. A few dissatisfied contractors, and others, impose on the credulity and stimulate the ambition of some member of the legislature to offer a petition, complaining of public grievances. A committee to investigate is appointed ;—subpœnas are issued, and straightway, swarms of hungry confederates throng the seat of government, to prosecute their claims before the legislature—to lounge at the public expense, and join in a wholesale pillage of the treasury. At the close of the session the committee reports,—the witnesses return to their homes, and laugh at the trick, as they pocket the spoils. By reference to this subject, it will be found that a large portion of the legislative expenses is incurred in this way. The extraordinary increase of these expenses, over those of all other departments of the government, has been of late years a matter of just complaint.

✓ EXPOSITION OF THE CAUSES WHICH HAVE CONDUCTED TO THE FAILURE OF MANY RAILROADS IN THE UNITED STATES. *By* CHARLES ELLET, JR., *Civil Engineer.*

There are completed, or in progress of construction, between three and four thousand miles of railroads in the United States, on which there has been expended, during the last ten years, more than one hundred millions of dollars, and for the maintenance of which there are now required annual appropriations of several millions, in addition to the loss of interest on this vast capital.

Of these works, some few have thus far sustained themselves, and distributed considerable dividends among their stockholders ; the receipts of some others are sufficient to keep them in repair, and pay the interest on the loans incurred for their construction ; but of the balance,—comprising between one and two hundred railroads, having an aggregate length of some two thousand miles,—the capitals may be regarded as positively sunk, and many of the companies as insolvent.

This disastrous result is not the consequence of attempting improvements in positions where the trade and travel were insufficient to authorize the necessary outlay of capital, but proceeds from the fatal practice of imitation, and a thorough disrespect of first principles.

The roads constructed by these unfortunate companies, instead of being such as appeared to be justified by the condition of the country in which they are situated, were only such as the engineer, or president, or leading stockholder had somewhere seen or read about. In the beginning, there was no particular object proposed to be attained ; and in the progress of the work, there was nothing

to rule the general plans, or govern the arrangement of the detail,—and they failed of course.

The object of a railroad is to convey passengers and produce; and the first question which every company, about to embark in such an enterprise, should propose for examination, is, What is the amount of trade and travel to be accommodated? for this amount furnishes us the value of the object sought by the improvement, and ought to prevent us from paying more for it than it is worth. And the second is, What should be the location and character of the road, and the character of its furniture, for the economical accommodation of the trade which it is found may reasonably be anticipated?

These are the essential questions for solution; but as obvious as the necessity for their investigation may appear, they have rarely, if ever, been systematically examined preparatory to engaging in the labor of construction. The amount of trade to be accommodated has never yet governed the plan, location and execution of any public work. All such enterprises in this country, and indeed nearly all the railroads in the world, bear one common impress, and every important sign of imitation of one common standard. They are all struck, as it were, with the same die, and belong to the same set. The same width of track, the same strength of rail, engines of the same weight, and cars of the same magnitude, prevail on the roads between the great cities of Europe, which carry half a million of tons, and some hundreds of thousands of passengers every year, and on those of the obscurest districts of the United States, where as many persons, and as much trade, will scarcely be witnessed in the course of half a century.

The imitation is universal. The same powerful engine, with its vast cars, is driven when loaded with a hundred tons of freight, or more than a hundred passengers, as when conveying its mere "tender" and empty train. It is so universal that the expenses of transportation are now frequently estimated by ascertaining the number of times the engine passes over the line, without any reference at all to the load which it draws. A late distinguished engineer, who had recently visited all the railroads in the United States, published, as a result obtained in his investigations, that it costs one dollar per mile to run a locomotive engine, and its train, on a railroad,—a result which he announced as a general fact, without qualification, and is nearly independent of the number of passengers conveyed, the distance travelled, or the tonnage forwarded. In other words, he came to the conclusion that it cost as much to send twenty passengers by railroad as it does to send two hundred, (providing they are carried by a single engine and train,) and as much to convey ten tons as to carry one hundred tons. Waiving the objections which may be urged against the generality of this conclusion, it must be admitted that, within certain limits, it is very nearly true, and precisely what ought to be anticipated from the facts. The rails, engine and cars are almost as much injured; the same capital is invested in the road and its furniture, and the same power and entire outfit are required, whether the trains be full or empty. The expenses could

not, therefore, be expected to vary much with the amount of the load.

And now, it may be asked, what is there wrong in all this? The company can only be expected to make the improvement, and provide for the business which it may have to perform—it is for the public to fill the trains.

The error consists simply in providing a power too great for the business to be done. There is scarcely an engine on any railroad in the country which is not competent to the movement of more than a hundred tons; and if such an engine make but two trips a day, and convey always a full train, it will carry nearly 150,000 tons in the course of the year. Now, there are nearly two hundred railroads in the United States, which are provided with all the locomotive power, and nearly all the means of doing a much greater business than this, and which have not the tenth part of this amount of business to do. There are few railroads in the country, over which twenty-five thousand tons of freight are carried in the course of a year. Here, then, is a great error. The road and its appurtenances, are a piece of machinery contrived to perform a certain duty; but so proportioned, by unskilful workmen, as to be ten times larger than is necessary; and consequently, ten times the capital is consumed in its construction, and nearly ten times heavier expenses than are really needful, are constantly incurred to keep it in operation.

To illustrate the case, I will suppose, that a stage proprietor has two routes on which he is compelled by contract to carry the mail and all passengers who apply; on one of which he knows that there will be at least ten persons and a large mail every day; and that to accommodate the public satisfactorily, he must employ a Troy built stage, and four good horses, adequate relays, and skilful drivers. He knows, too, that on the other—a remote and obscure route—there can never be more than two or three passengers, frequently none at all, and a mail-bag equal to a school-boy's satchel, all of which could be conveniently carried in a light one-horse wagon. But being conscious of the dignity of his calling, and ambitious to sustain it; and having, withal, certain preconceived notions of what constitutes a "stage line," he determines, at once, to put four-horse coaches on both routes. With a knowledge of these facts, should we be surprised to hear him affirm, at the end of a year, that it does really cost very nearly as much to run his team on the obscure line as on the popular thoroughfare—to drive his heavy and empty four-horse coach over its daily route as it does the full one—or to hear him complain that staging is a losing business?

Yet this man is no less wise, no less provident, no less skilful in the conduct of his business, than are the directors of nine-tenths of the railroad companies in the United States. They do not proportion their roads, engines and cars, to the business to be done; nor do they seem to have glanced at the *objects* for which their works were intended, with a view to adapt them to their accomplishment. They commit the error which I have attempted to illustrate. They make costly roads, build expensive superstructures, rear extra-



gant edifices to contain their cars and engines, run heavy locomotives, and use carriages almost as capacious as dwelling houses, to carry as many passengers as could without much inconvenience be drawn in a hand-cart. There is no exaggeration in this description. Every traveller must have witnessed it on all the branch roads over which he has had the misfortune to travel.

In short, the roads of this country, and all the departments connected with them, possess a power, without proportion, greater than the business of the country will warrant; and *this is one of the causes of the failure of the system.*

Again, the same error which occurs in the first plan and future management, characterizes the construction of the road.

Before laying the rails, a certain operation is performed, which is called "grading," by which is understood the taking off the tops of hills, and filling up of hollows, so as to reduce the whole line to a succession of levels, or very uniform inclined planes. This work is apt to involve an outlay, varying from five thousand to thirty thousand dollars per mile—the exact amount depending on the fancy of the company, or on the formation of the country, but wholly independent of the amount of trade to be accommodated.

I have witnessed—to name one case out of a multitude with which it may be appropriately compared—an expenditure of more than three hundred thousand dollars, in a space of twelve miles, for grading a road, which has never enjoyed a trade exceeding six thousand tons in a year. The interest on this capital amounts to eighteen thousand dollars per annum, or considerably more than it would cost to send in wagons all the tonnage for the benefit of which it was expended.

The object of a railroad is to reduce the cost of transportation; and the object of cutting down hills and raising valleys, is to enable us to carry the trade over the gentler ascent, cheaper than it could be taken without the expenditure. The capital appropriated ought not, therefore, to be so great, that the interest on it would exceed the cost of doing the business without the facilities acquired by the sacrifice. In all such works there should be an object in view, and this object, whatever it be, must have its value. If the trade be two hundred thousand tons per annum, and it be desired to reduce the acclivities of the ascents so as to save one cent per ton per mile, it is obviously proper to expend a capital which would produce two hundred thousand cents a year. For such an object it would be admissible to expend some \$33,000 per mile in the construction of the road;—but not more than that. But if the trade were only six thousand tons, as in the case to which I have adverted above, it would not be good economy to expend a greater capital for this object than would yield six thousand cents per annum, or about \$1,200 per mile. But what was the practice on this line, and what is the practice on a hundred others like it? It is to cut down hills and fill up cavities, on the most insignificant roads, of a magnitude that should cause the strongest company in the country to pause, and consider well and maturely before venturing to encounter them. The company of which I have spoken, and others that I need not

name, have expended \$25,000 per mile in grading a road, to accommodate an amount of trade and travel which could have been carried forever by two or three locomotive engines of two tons weight, on a road which need not have spoiled more than a width of ten feet of ground, and which, with all its essential fixtures, could have been built for two thousand dollars a mile. They expended twelve times the capital that was necessary, and they incur yearly expenses as many times greater than are really called for, in consequence of having laid out too great a capital. This is another of the errors to which I have adverted.

I will add a word in reference to the remedy.

It should be the business of every company, first to ascertain the trade and travel on the line where it is proposed to operate; and next, to build the road and stock it, with reference to the amount of business previously determined. This advice is so obviously correct—its propriety so evident—that it may be supposed the practice recommended could scarcely have been neglected. But, self-evident as it may appear, I am sustained by the history of our improvements in asserting, that it has never yet been observed.

If the company can anticipate but *eighteen or twenty passengers* a day, let them make a light wooden road—avoid the use of iron nearly or quite altogether—make no embankments or excavations, and follow very closely the undulations of the soil, as they occur under a skilful location of the line. Let them calculate, at every point the expense of removing obstacles, and never lay out more money to reduce a grade than the value of the additional power necessary to carry the eighteen or twenty passengers over it. Let them put on engines of *half a ton, one ton, or two tons weight*, instead of ten or twelve tons, with power only adequate to the certain accomplishment of the duty to be performed, and let them provide cars as light as one-horse pleasure carriages. Such a road, in ordinary cases, would cost from one to two thousand dollars a mile, instead of twenty thousand; such engines would cost but five or six hundred dollars a piece, instead of six or seven thousand; and such cars could be made for two hundred dollars, in place of twelve hundred. Let them build a car and engine shed, twenty feet square, at a cost of fifty dollars, instead of laying out, all along the line, some thousands for that purpose. Instead of a host of agents to keep up the road, to watch the track, to clean out ditches, repair embankments, feed the vast engines and move the huge cars, let them employ one faithful hand as engineer, conductor, fireman and treasure, and another, if the road be not very small, as superintendent and general commissary.

Such is the establishment to be recommended for such a case. And let it not be supposed that this is too contemptible an affair to be called a "railroad." The slight engine would possess sufficient power for the duties exacted of it; the carriages, though light, and comparatively cheap, would be exceedingly comfortable, and even elegant; the stock would be a profitable object of investment; the line and its furniture would not be too large to be kept in good repair; the public would be well accommodated, and—a consideration not

to be treated with entire contempt—the company would either have no debts to pay, or be capable of paying them. The road, if ten or fifteen miles long, would cost but \$20,000, instead of \$200,000; the annual expense would be but \$200 per mile, instead of \$2,000; and the gross income of the cheap road—in consequence of its occupying the same ground, and being less liable to accident—would be positively greater than that of the other.

I put it to one hundred railroad companies which are now lingering out a sickly existence, to say, under the light that experience has afforded them, whether the adoption of these recommendations would not have been their better policy; and I put it to those companies that have not yet gone quite far enough to ruin themselves, to consider whether it would not be better for them to pause, even now, and examine their condition before they go further.

If they have not yet laid their superstructure, and exhausted their resources, there may be time to change, and extricate themselves from ruin, their capital from the gulf of endless expenses. They may doubt the correctness of my views; they may doubt whether any other sort of engines, any other cars, or other roads than those in use, could be advantageously employed. They may rely on what they call the public judgment, which has settled down in favor of the present system. This may seem well, but it would be better to use their own judgment. Let them ask whether it can be judicious—put the question their common sense—whether it can be necessary to employ a locomotive engine of seven tons weight and twenty horses power, two or three agents to manage it—a tender of three or four tons weight—one or more enormous cars—making altogether a moving mass of fifteen or twenty tons—and construct a road adequate to bear it all, and use fuel enough to drive the machinery of a large manufacturing establishment, to convey a load of ten or a dozen passengers?

*If railroads do not sustain themselves, it is not because they are railroads, but because great roads have been constructed where little ones only were required.* I do not believe that there has ever been such a work commenced, nor probably authorized, which could not pay a liberal and honest dividend, if the road, stock and entire apparatus, were duly proportioned to the duty to be performed.

The road and arrangements that are appropriate enough between London and Birmingham, or Liverpool and Manchester, would do but a small business, I imagine, if transferred to the prairies of the West. In fact, the people of Illinois have found it so. The power contrived to drive a grist-mill, would make but small dividends if applied to turn a churn.

It is far from my object to advocate the exclusive employment of cheap roads, and light stock; my intention is only to recommend them, as I would a light carriage, or light machine, where true economy, convenience and comfort dictate their adoption. A larger business will demand more extensive preparations; and in this connection, I will repeat remarks which I have elsewhere written when discussing this subject under another form: "An increase of business will give rise to improvements in the system adequate to its

wants; and we must not consider a canal liable to breaches, with single locks and of imperfect construction; nor a railroad with an insecure foundation, liable to derangement from frost, and to obstruction from slides, and traversed by locomotives equally inadequate, as the means that would be provided to give passage to the whole trade of a continent. When the business created by a population of many millions has to be transacted along the line of canal or railroad, every resource that can be obtained from the increasing application of science and art, will be brought in requisition. The canal will be provided with an additional towing-path, and as many locks as are necessary; the valves will be adjusted to the time of filling essential to the purpose; the banks will be strengthened until breaches are impossible, and protected against the waves by an indestructible material; the mountain streams will be passed under, and the washings of every acre will be discharged through adequate openings. The railroads will be still more improved; their foundations will be more permanent, the rails will be more substantial, the drainage will be perfect; the weight of the engines will be increased, the cars made more convenient, and the trains, if necessary, will be driven by a power adequate to the management of a thousand tons.

"Under such circumstances, the transshipments will take place at points where the population of great cities may engage in the shifting of the produce from the boats to the cars, and from the cars to the boats. The lines will terminate where they can approach the shipping, and the trade at the port need only be limited by the capacity of the improvement."

These remarks were written in discussing the possibility of giving vent to the whole of the surplus produce of the valley of the Mississippi, when much more highly improved than it will be in the next quarter of a century, by a single railroad from the Ohio to the Atlantic.

My intention is to advocate nothing exclusive. I propose to place large roads and strong roads, and easy grades and powerful engines, where there is a trade to justify the necessary expenditure. But to make the provision in all cases commensurate with the duties to be performed—the trade and travel to be accommodated. The fulfilment of this condition will exact the adoption of engines of every capacity, from that due to a half ton, up to twenty-five tons weight, and of roads adapted to the power of the engines. I recommend the use of means proportional to the end to be accomplished.

PHILADELPHIA, November 20, 1841.

[From the Civil Engineer and Architect's Journal.]

#### ENGINEERING WORKS OF THE ANCIENTS.

Dionysius of Halicarnassus, who lived in the time of Augustus, is the next author who contributes to our series, having extracted from his Roman Antiquities the following accounts of Roman works:

\* Essay on the Laws of Trade, p. 105.



*Bridge over the Tiber.*—Ancus Marcius, the 4th King of Rome (B. 3, ch. 14,) is said to have been the first who built over the Tiber the famous wooden bridge, which is considered as sacred. It must only be made of wood, and neither iron nor copper may be used in it. When any damage occurs, it is the duty of the pontiffs to see to the repair, and to perform certain sacrifices prescribed by law during the progress of the works.

Ancus Marcius greatly enlarged the city of Rome, and built the port of Ostia at the mouth of the Tiber.

*Sewers.*—Tarquinius Priscus, the 5th King (B. 3, ch. 20,) built the walls of Rome of large squared stones, and commenced the sewers, by which the waters are collected in the streets of the city, and carried into the Tiber. The work is admirable, and beyond any thing that can be said. For my own part, I believe that Rome has nothing more magnificent, nothing which better shows the grandeur of her empire, than her aqueducts, streets, paved roads, and sewers; I judge thus not only on account of their utility, but still more on account of the immense outlay which they have required. To prove what I assert, I will only instance the sewers. According to Caius Aquilius, having been for some time so neglected that they were stopped up, the censors concluded a bargain with a contractor to clean and repair them for a thousand talents.

We cannot pass over this tribute of the old historian without remarking that while the temples of Greece are scattered in ruins, and their proudest ornaments become the trophies of barbarians, the roads, aqueducts, and sewers of the Romans still minister to the wants of nations, centuries after the power of their founders has ceased to exist. The English emulate the Romans in the useful nature of their enterprises, and we trust that the labors of our engineers may minister as long to the service of the world as those of their predecessors.

*Great Circus.*—Tarquin also embellished the Great Circus between the Aventine and Palatine mounts, and was the first who constructed around this circus covered seats, whereas the practice formerly was to place scaffolding around.

*Tarquinius Superbus.*—Tarquin the Proud (B. 4, ch. 10,) the seventh and last king of Rome, employed the people on the public works in order to occupy them and prevent them from plotting. He continued to the Tiber the sewers begun by his grandfather, and carried out several of his unfinished works.

*Strabo.*—Having thus dismissed Dionysius of Halicarnassus, we come to Strabo, one of the most celebrated of the geographical writers of the ancients, and from whom, as from Diodorus Siculus, much information is to be gleaned as to ancient mining, a most important branch of engineering, as bearing upon earthworks. We shall first take the third book.

*Mines in Spain.*—A chain of mountains, (the Sierra Morena,) parallel to the Betis (Guadalquivir) extends towards the north, ap-

proaching more or less the banks of the river; it contains a great many mines. Silver is found everywhere in the neighborhood of Ilipo and Old and New Sisapone (Almaden.) Near the place called Cotinas, gold and copper are worked together. The mountains on the banks of the Anas (Gaudiana) also contain mines.

From Turdetania is exported cinnabar equal to that of Sinope. There is also found fossil salt.

What renders Turdetania particularly remarkable is its excellent mines. In fact all Iberia is full of them; but Turdetania unites all the advantages of a mining country to a degree which surpasses any praise. In no country in the world do we find gold, silver, copper and iron in such quantity or of similar quality. Gold is obtained not only from the mines but also from the rivers and streams, in which it is contained mixed with sand. It is also to be found in many dry places, but with this difference, that in these it cannot be distinguished at sight, while it shines when covered with the water. This is the reason why water is made to pass over sandy places, to make the particles of gold shine. Wells also are dug, and many means have been invented for separating the gold from the sand by washing, so that there are more gold washing works in the country than mines. The Gauls assert that their mines, as well as those of the Cevenes as those of the Pyrenees situated on their side, are better; but, nevertheless, the mines on the Spanish side are generally more esteemed. Among the particles of gold are sometimes lumps of gold weighing half a pound, which are named *pales*, and require very little refining. In cutting stones of ore, small lumps of this metal are sometimes found. After having roasted the gold intended to be purified, by means of an aluminous earth mixed with it, the result of the operation is the alloy of gold and silver known under the name of *electrum*. It is again placed in the fire, which separates the silver, and leaves the gold pure; for this latter metal is easily fused, and is not of much hardness. It is also fused sooner by the flame of straw, which, being milder, agrees better with the nature of gold, which obeys its action, and dissolves easily, while charcoal, being stronger, consumes a great part by liquefying it too soon, and converting it into vapor. As to the beds of rivers, the particles are extracted, washed in buckets, or in wells or holes made near, and the earth is washed. The furnaces for melting silver are generally made higher, to enable the pernicious vapor of this metal to rise and be dispersed. Some mines of copper have the name of gold mines, whence it is presumed that they formerly supplied this metal.

Posidonius, in speaking of the number and excellence of these mines, used all the exaggerations of an enthusiast. The Turdetanians, says he, use the greatest industry and labor in digging winding galleries far into the earth, and often in draining, by means of Egyptian spirals, the subterranean streams with which they meet. But their lot, he observes, is very different from that of the miners of Attica, to whom may be applied the ancient enigma, "They have not taken all that they have drawn from the earth, and they have left there what they possessed." The Turdetanians, on the contrary,

draw from their mines enormous profits, since the fourth of the earth which they extract from the copper mines is pure copper; and the silver mines furnish private individuals in three days with a quantity of this metal equivalent to a Euboic talent. As to tin, according to the account of Posidonius, it is not found on the surface of the earth, as some historians assert, but it is also extracted from mines. Mines of this metal are found among the barbarious people who inhabit beyond the Lusitanians and in the Cassiterrides islands, and tin is also brought from the British islands to Marseilles. Among the Artabri, in Gallacia, the last people of Lusitania, on the north and west, there is earth covered with a dust of silver, tin, and of the metal, known under the name of white gold, on account of its alloy with silver. This dust is brought down by the rivers, raked up by the women, and then washed by them in sieves placed upon baskets. This is what Posidonius says as to the mines of Iberia.

Polybius, in speaking of those of silver which exist near New Carthage (Carthagena) says that they are 20 stades from the city, that they are so great that they extend over a district of 400 stades in circumference, that they habitually employ 40,000 workmen, whose labor brings to the Roman people 25,000 drachms per day (about £350,000 per annum.) I do not enter into the detail of all the other operations, which would be too long, I confine myself to what Polybius says as to the manner in which the silver is treated, which is contained in the rivers and torrents. After having pounded and sifted it over water, what remains is separated from the water and pounded again; after having been sifted again, it is pounded and sifted five times in all. After this the pulverized matter is melted to separate the lead contained in it, and the silver remains pure. These mines of silver still exist, but there and elsewhere they belong to the State no longer, but have been taken possession of by private individuals; those of gold on the contrary mostly belong to the State. Here as well as at Castalon (Caslona) and in other places are mines of lead, which contain silver, but in too small quantity to defray the expense of separation.

A little way from Castalon is the mountain whence the Betis (Guadalquivir) springs; it is named the Silver Mountain, on account of the mines of that metal which it contains.

Lusitania is watered by great and small rivers which contain many grains of gold. Although the country abounds in gold, the inhabitants preferred living by plunder.

The mountains in the neighborhood of Malacca (Malaga) contain in several places mines of gold and other metals.

Not far from Dianium (Denia) are very fine forges.

*Works in Spain.*—In the neighborhood of Asta (Mesa de Asta,) Nebrissa (Lebrisa,) Onoba (Gibraleon,) are canals dug in several places to facilitate the navigation.

Near Cadiz is to be seen the Tower of Cæpio, built on a rock, washed on every side by the sea. This admirable work was constructed in imitation of the Pharos of Alexandria.

*Scilly islands.*—The inhabitants trade in the tin and lead which they dig from their mines. Publius Crassus, who went there, found that their mines are not very deep.

*Works in Gaul.*—The extracts which follow are from various books.

Marius, perceiving that the mouth of the Rhone was becoming gradually shoaled up, had a new channel dug, which received the greater part of the waters. This canal he gave to the Marseillaise in recompense for their service in the wars, and it became to them a great source of riches on account of the dues which they levied on those who went up or down.

The road from Iberia to Italy passes through Nimes. It is good enough in summer, but very bad in winter and spring, on account of the rivers overflowing and depositing mud. This road passes several rivers by boats, or by bridges of stone or wood.

The territory of the Cevennes abounds with gold mines.

The Tarbelli, a people of Aquitaine, are in possession of the most esteemed gold mines; for without digging deep, lumps of gold as big as the hand are sometimes found, requiring only a slight washing. The rest of the mine consists of grains and lumps, which do not either require much work.

*Britain.*—Britain produces gold, silver, and iron.

*Lipari.*—Lipari has very productive mines of alum.

*Roman roads and bridges.*—The Romans, says Strabo, have principally employed themselves upon what the Greeks have neglected—I mean paved roads, aqueducts, and those sewers which drain the city of Rome. In fact, by cutting through mountains and filling up valleys, they have everywhere throughout the country made paved roads, which serve to convey from one place to another the goods brought by sea to the ports. The sewers of Rome, arched with dressed stone, are broad enough in some places for a cart laden with hay to pass; and the aqueducts bring water in such abundance as to form streams running across the city, cleansing the sewers, and are sufficient, as it may be said, to supply all the houses with great fountains, canals and reservoirs. This last advantage is principally owing to the cares of Marcus Agrippa, who has decorated Rome with many other public monuments.

The principal of the great roads which traverse the country, are the Appian Way, the Latin Way, and the Valerian Way.

According to modern account, the Valerian Way was about 100 miles long; for the first 15 miles are found ruins of bridges, causeways, etc. Beyond, the remains of it are not so evident, but the boldness with which it is carried across three mountain chains is surprising.

Near the city of Como, to master the people disposed to robbery, roads have been constructed, which are as practicable as it is possible for art to make them. Augustus, not content with clearing the roads of the banditi, has made them as convenient as possible, although the country is very difficult.



M. Emilius Scaurus constructed the Emilian Way running to Sababata and Darthon; and there is another Emilian Way, which continues the Flaminian Way, and was the work of M. Emilius Lepidus, colleague of C. Flaminius. (This is an error of Strabo in attributing the Flaminian way to this Flaminius.)

The Salarian Way is a great road very short. To it joins the Nomentan Way.

The Appian Way is paved from Rome to Brendisium (Brindisi,) and is the most frequented of all the roads made in Italy. Beyond Terracina on the Roman side, the Appian Way is bordered by a canal, which receives the water of the marshes and rivers. It is particularly by night that this way of the canal is preferred; upon it people embark in the evening, and leave it in the morning, and take for the rest of the journey, the Appian Way, but even in the day-time the boats are towed by mules.

Near Baïæ is an isthmus of a few stades, through which a road is tunnelled. Near Naples is a similar one, which, in the space of several stades, crosses the mountain situated between Neapolis and Dicearchia. Its breadth is such that carriages which meet find no difficulty, and light is admitted by several openings pierced internally from the surface of the mountain through a great thickness.

The Aternus (Pescara) in the country of the Peligni is passed by a bridge 24 stades from Corfinium.

*Canals.*—The greater part of Transpadane Italy is full of lagunes, and therefore the inhabitants have made canals and dykes as in Lower Egypt, a part of the inundated ground being drained and the rest navigable.

Epiterpum, Concordia, Atria, Vicetia, and some other small places in the neighborhood of Ravenna, by small navigable canals, communicate with the sea.

The Cispadane was for a long time covered by marshes, which arose from the superabundance of the waters of the Po, but Scaurus, by having navigable canals dug from Placentia to Parma, drained the plain.

Ravenna is a great city built on piles in the midst of the marshes, and intersected with canals, which are crossed by boats or bridges.

*Dyke.*—The Locrine Gulf in its breadth extends as far as Baïæ, and is separated from the external sea, in a length of 8 stades by a dyke broad enough for a great wagon to pass. This dyke it is said is the work of Hercules; as in rough weather the waves flowed over it so as to make it impassable for foot-passengers; Agrippa had it raised higher.

*Timber.*—From Tyrrhenia (Tuscany) is obtained timber for building, of which is made very long and straight beams.

Pisa supplies timber for building much used by the Romans.

*Cement.*—Dicearchia or Puteoli has become a place of great trade, on account of the works by which it is sheltered, having in the sand

of the neighborhood (puzzolana) great facilities for such constructions. This sand employed in a certain proportion with lime, makes a body, and becomes very solid.

*Mines and Quarries.*—The Salassi have gold mines, the working of which was facilitated by the Durias (Doria) which supplied the water required for the washings; so that, by diverting the courses by numerous branches, they often dried up the main bed, which was the cause of constant war with the neighboring people, whose agriculture was affected. The Salassi, although conquered by the Romans and dispossessed of their mines, being masters of the mountains, continued to sell water to the mine contractors.

Polybius relates that in his time among the Taurisci Norici (people of Corinthia, Istria, etc.) were mines of gold so rich that by digging the ground only two feet deep gold was met with, and that the ordinary works were not more than fifteen feet deep; that a part was native gold, in grains the size of a bean or a lupine, which in the fire only diminished an eighth, and that the remainder, although requiring to be more purified still, gave a considerable product. [He adds] that the Italians having entered into agreements with the barbarians for working these mines, in the space of two months the price of gold fell throughout Italy a third, and that the Taurisci having perceived it, turned out their foreign colleagues, and sold the metal themselves. At the present day the Romans possess these mines. The rivers, also, like those of Iberia, contain grains of gold, although in smaller quantity.

Near Acyleia (Aquileia) are mines of gold and iron easy to work.

Cisalpine Gaul has mines which are not worked so much as they used to be, perhaps because they produce less than those of the Transalpine Celts and of Iberia, but formerly they were worked very much, since a mine of gold was wrought even in the territory of Vercelli.

In the territory of Poplonium (Capo di Campana) are some abandoned mines, and the forges in which is wrought the iron of Elba, which, as it can only be reduced in the furnaces, is transported to the continent, as soon as it is brought out of the mine. Strabo says that the excavation of these mines grew up.

Pithecura (Procida) has gold mines.

Near Luna, in Tyrrhenia, are the quarries of marble, white, and spotted with green, of which tables and columns are made of a single block. These quarries are so numerous and so well supplied, that they are sufficient for most of the fine works which are made at Rome and throughout Italy.

The Pisan territory has an abundance of marbles.

Gabii near Palestrina is in the midst of the quarries most used by the Romans.

At Tibura (Tivoli) are quarries of those different kinds of stones known under the names of Tiburtines, Gabians, red stones, of which most of the Roman buildings are constructed.

UNWILLINGNESS OF MAN TO INVESTIGATE, AND HIS WILLINGNESS TO COPY.—By OLIVER BYRNE, *Professor of Mathematics, College for Civil Engineers, London.*

It is difficult to make men think for themselves; most of us would rather take what we hear for granted than be troubled with the investigation, when, our private ends are not concerned: and against that again, we find men opposing the most reasonable, and upholding the most absurd doctrines to support a party, to fill their purses, to gratify a pride, in order to be thought singular, or to astonish, that it may please the mass of mankind, for they are fond of the wonderful.

Again, in things that are really useful, "some are too indolent to read any thing till its reputation is established; others too envious to promote that fame which gives them pain by increase. What is new is opposed because most are unwilling to be taught; what is known is rejected, because it is not sufficiently considered that men more frequently require to be reminded than informed." This article is written to show the willingness of man to copy, and his unwillingness to investigate: and nothing can show this more clearly than the errors which are promulgated and transmitted from age to age by those who are called "learned." In a mathematical investigation, an investigation in which the mathematician is willing to occupy the most unfavorable position, he requires from you the exercise of no prejudice in his favor; but, on the contrary, would invite you to indulge in the most scrupulous frame of mind, to use the utmost penetration to discover a flaw, aye, to put the whole of your mind in opposition to him, and yet in spite of all your opposition, he will engage to convince you of the truths he proposes to establish.

In this science, the sanctuary and strong hold of absolute certainty, which claims exception from the infirmities that are attached to all other branches of human knowledge, and although what we thus establish is real truth, subject to no abatement—no modification—depending upon no hypothesis of man,—upon the authority of no great name,—mathematical truths will be the same one thousand years hence as they are at the present day, standing immutable amidst all the changes of systems and the fluctuations of opinion.

And yet, either from (as I have before mentioned,) an unwillingness to investigate, or from an inclination to copy, we find oversights, mistakes, logical absurdities, and errors, of the numerous investigators and copiers. We shall here give a few instances:—Simpson, the great mathematician, in his *Elements of Geometry*, which work passed through eight editions and was translated into almost all the languages of Europe, and must have been read by thousands for upwards of eighty years, we find the following erroneous proposition:—

"Two triangles that have two sides of the one proportional to two sides after other, and an angle in one, equal to an angle in the other, opposite homologous sides, are similar."

Sir David Brewster, in his translation of *Legendre's Geometry*, falls into a notable error, insomuch that he makes assertions which

are not at all true. In speaking of Legendre, he says, "the author has provided for the application of proportion to incommensurable quantities, and demonstrated every case as it occurred, by means of the *reductio ad absurdum*."

Professor Leslie's Elements of Geometry is remarkable for false demonstrations; and in his fifth book he demonstrates the propositions or proportion to be true, when the magnitudes are commensurate. The fact that those demonstrations do not hold good when the magnitudes are incommensurable seems well known to Mr. Leslie; but that those magnitudes should also be homogeneous is altogether neglected by him.

Bonnycastle, in two of the principal propositions of his fifth book, gives demonstrations undoubtedly intended for general ones, which only apply to cases where all the magnitudes are of the same kind. That those demonstrations were intended for general ones there can be no doubt, for in his notes, page 257, Bonnycastle finds fault with Euclid's method of composition and division of ratios, as not being sufficiently general respecting these points,

Dr. Austin, in his "Examination of Euclid," commits the same error as Mr. Keith, who being desirous of applying a new demonstration to Proposition XVII, of his edition of Euclid, he employs alternation to quantities whose antecedents might be heterogeneous.

Professor Young, of Belfast, who so ably criticised many of our modern writers on Geometry, in cultivating the ideas of M. da Cunha, on the doctrine of ratios, falls, himself, if not into an error, into a great inconsistency—that of discarding Euclid's doctrine of ratios from his fifth book. He undoubtedly treats geometrical proportion without using the term "ratio," but he gives other terms of a more lengthened nature, which precisely convey the same meaning. Now to do away with the term "ratio" here, is to do away with it in every subject that follows, or through a whole course of mathematics, and any such attempt should not be entertained, for it is not so very difficult to define what is intended to be expressed by the term "ratio." It is a different thing to have a clear conception of what the technical term "ratio" is meant to convey, from knowing that what is intended by the term cannot be expressed in many cases by numbers.

Babbage, in speaking of his table of logarithms, says, the proofs of the present tables were read three times: 1st, with the marked copy of Callet's logarithms; secondly, with a copy of Hutton's logarithms, fourth edition, 1804; thirdly, with a copy of Vega's logarithms, folio, 1794. They were now received from the printer, and were again compared with the logarithms of Vega; fifthly, they were read with those of the Trigonometria Artificialis of Briggs.

They were next returned to the printer and stereotyped, and the proofs from the plates were read; sixthly, with the logarithms of Vega; seventhly, with the whole of the logarithms of Gardiner; eighthly, with the logarithms of Taylor, and, ninthly, by a different set of readers, they were again read with the logarithms of Taylor.



After all this care and investigation, I found an error in Mr. Babbage's work not long since.

Bowditch copies the oversights of La Place. Most of our English mathematical works are translations from the French; and in the higher branches, Lardner and others not only copy the works, but also their errors, and in many cases, typographical ones.

The 17th lemma of Newton's Principia, edit. 1713, is wrong.

In conclusion, I will ask those who are willing to investigate, where did Tredgold get the number 449, so often used by him in his work on the steam engine, etc. ? See Woodhouse's edition, page 84, where it is first introduced.

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[From the Miners' Journal.]

#### OPENING OF THE POTTSVILLE AND PHILADELPHIA RAILROAD.

The 1st day of January, 1842, will long be remembered in the Coal Region; in fact, it never will, never can, be forgotten. The chronology of our region will take that auspicious day as a mark—a guide for every occurrence, great or small, that has taken place prior to it, and for all the sayings and doings that will take place in future. Although in mid winter, the day was bright, balmy, beautiful! The sun shone forth in all its glory, majesty and splendor. Its genial rays were felt and seen everywhere. The snow melted under its warm, dissolving touch. Our noble hills and mountains, but the day before covered with a white, glittering, sparkling dress of virgin snow, looked like pieces of patchwork, with spots of snow and the still green ground peeping forth in all directions, like pearls and emeralds, and not unlike soap suds on the green velvet sward.

We said it was a bright, balmy, beautiful day! We fervently trust that it was an omen of better times. At an early hour, our bustling town assumed a still more bustling appearance than usual. The old and young were abroad, with smiling faces, light hearts, and thick breeches. The "teetotallers" were abroad, too, a well dressed, happy looking set of noble fellows, strong in numbers and strong in their resolution to abjure the beastly habit of intoxication. Our different bands of music were also abroad, making the air vocal with strains of martial and soul-stirring music. Most of the ladies were at home, their beautiful faces wreathed in smiles, receiving their annual visitors with that open, kind hearted hospitality, for which the gentler sex of our region have ever been so remarkable. The public places of worship were not neglected; and many were assembled in them, to render homage and thanks to the Great Disposer of all events, for the blessings vouchsafed to them during the past year.

It was a day of joyous anticipation. The road which connects Pottsville with Philadelphia was to be opened on that day, and a locomotive, with the president, directors and officers of the railroad company, were hourly expected to arrive at the depot, below our

borough. About noon, the whole town was thrown into a state of high excitement. The locomotive was in sight! The thin white vapor, as it escaped from the locomotive, could be seen hovering in the gorge of the South mountain, and the hurried panting of the *escape* announced the approach of the locomotive long before it was in sight. The directors, etc., on their arrival, proceeded to the Mount Carbon House, where they were surrounded and welcomed by numbers of the citizens of Pottsville. A hasty repast having been prepared, the company adjourned to the dining room, and all were as happy and as joyous as good feeling, good wine, and agreeable anticipations could make them. Mr. Edwards, in behalf of the president and directors of the railroad company, announced that they would partake of the preferred hospitalities of the region on Tuesday next, at the same time inviting our citizens to pay a visit to Philadelphia *en masse*, over their road, free, gratis, and for nothing, on the coming Monday. The annunciation and invitation were received with great applause. In the meantime, hundreds of our citizens, preceded by a band of music, had assembled at the depot, gazing with wonder and pleasure on the first locomotive that had penetrated into the fastnesses of the Coal Region.

The directors made but a short sojourn, as it was necessary for them to be in Philadelphia early in the evening. By two o'clock they were all seated in the car, and in a few minutes the signal was given, and the locomotive darted away with the greatest rapidity, amid the waving of hats and the tallest kind of huzzaing. They left the depot precisely at ten minutes past two o'clock, P. M., for Philadelphia, and arrived at Peter's Island Bridge ten minutes before eight o'clock. Total time, including stoppages, five hours and forty minutes. Total running time, four hours and forty-eight minutes. This is a great performance, considering the state of the road,

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**EFFORTS TO DIVERT TRADE FROM NEW YORK.**—In connection with the recent completion of the Great Western railroad to Boston, it may not be uninteresting to our citizens to be informed of the projects in contemplation by our Canadian neighbours, and the people on the upper lakes, to open a route for western trade, from Lake Erie to the Ocean, by way of Montreal and Quebec. A writer in the Toledo Blade, furnishes some important information on the subject. The great works undertaken by Canada, are expected to be completed in about three or four years. The Welland canal will enter Lake Erie some 45 miles above Buffalo, and the writer argues that it will be nearly as cheap to land goods brought up through it, at Cleveland and Toledo as at Buffalo. The locks now building on the St Lawrence portion of these works, are 200 feet long and 45 broad, with 9 feet water on their mitre sill. The recommendation of the chief engineer, that all the locks, from Montreal to Lake Erie, should be of the same dimensions, is understood to be adopted, and this, he says, will enable large steamers and sailing vessels of 300 tons to pass through from the Lakes to the Ocean. The number of

miles of canal, lake and river navigation, the number of locks and feet of lockage, from Port Colborne, at the head of the Welland canal, on Lake Erie, to Quebec is as follows: Canal navigation, 60½; river do., 526½; number of locks, 63; feet of lockage, 517.

When the Welland canal is finished to the mouth of Grand River, it will be 140 miles long, thus extending canal navigation from the upper lakes to Quebec, 72 miles, and shortening lake navigation about 20 miles. The writer alluded to, goes on to say:

"The distance from our harbor to Montreal will be about 600 miles—being a little less than to Albany. The route to Montreal will have but 72 miles on which tolls will be paid;—that to Albany has 363 miles by way of Buffalo, and upwards of 200 by way of Oswego. To Montreal there will be no transshipment—to Albany there must be one. The distance to Quebec and New York, from the ports of the upper lakes will be about the same. To the former, there need be no transshipment—no breaking of bulk; to the latter, there is commonly two, one at Buffalo or Oswego, and one at Albany. To Quebec we can go in wooden steamers of 500 tons—or in iron steamers of 800 tons; to New York, we must, a great part of the way, use canal boats, carrying about 40 tons. If sail vessels should be used at Quebec, they may be constructed to carry 300 tons, and they may be towed up and down the St. Lawrence from Ogdensburg, say 270 miles, by a steam tug, as cheap at least, as canal boats can be drawn on the 40-foot-wide Erie Canal."

**FREIGHT BUSINESS ON THE NORWICH AND WORCESTER RAILROAD.**—But few of our readers are aware of the quantity and value of the merchandise and produce that pass weekly over this road. Upon inquiry, we learn that from the 1st of January last to this date, the receipts from freight alone *average* something more than \$1,000 per week; and for the last eight months, \$1,150 per week.

We understand that it is intended to arrange a line of packets for the next season, and start one every day for Norwich and New York. Also, to place upon the route to New York one or more steam freight boats. By these arrangements, and suitable efforts, it is believed that this branch of business will amount to \$1,500 per week, or \$75,000 for the year 1842,—a sum more than sufficient to pay all the expenses of the road.—*Norwich Courier*.

**A PROFITABLE RAILROAD.**—A memorial to the Legislature of New York states that the nett profits of the Utica and Schenectady railroad for the last five years have been \$238,887 per annum on an average, or 13¼ per cent. per annum on the capital, and praying the Legislature to restrict the rate of fare to two cents per mile.

**DIVIDENDS.**—The Auburn and Rochester railroad company has declared a dividend of nine per cent., payable 1st of January, to stockholders on the books in this city, at the Bank of the State of New York. The road has been completed only about three months.

**IRON MANUFACTURE IN PENNSYLVANIA.**—Such statistics as the following, which show the magnitude of the resources of our widely extended country, are well worthy of record. They are copied from the concluding passages of an article on the iron manufactures of Pennsylvania which appears in the Harrisburg *Intelligencer*:

Productions of iron.		Tons of pig iron.
210 charcoal furnaces, yielding	-	98,350
12 mineral coal, say	-	15,000
Total pig iron, \$30 per ton,	-	113,350
		\$3,400,500

*Manufactures of iron.*

70,000 tons made into bars, additional value,	-	2,800,000
71,000 tons castings, do. do.	-	5,000,000
65,000 tons rolled iron, do. do.	-	3,474,979
Iron in 270 steam engines, do. do.	-	700,000
7,017 tons nails, do. do.	-	253,110
Scythes and sickles, do. do.	-	15,000
Edge tools, do. do.	-	110,000
Cutlery, do. do.	-	25,000
Shovels, spades and forks do. do.	-	30,000
Guns, do. do.	-	185,074
Cars, and other vehicles, do. do.	-	900,000
Ploughs, iron, do. do.	-	107,000
Sheet iron manufactures, do. do.	-	100,000
Articles made by blacksmiths, do. do.	-	5,000,000

\$22,100,665

Thus it will be seen that the iron produced in Pennsylvania, and the additional value given to it by our mechanics, amounts annually to more than the sum of *twenty-two millions of dollars*.

There is also consumed in the manufacture more than 180,000 tons of anthracite and bituminous coal.

There are employed in the manufacture of iron in all its branches more than 20,000 workmen, so that, with their families, depending upon the iron business, we have a population in Pennsylvania of more than 120,000 persons.

**OGDENSBURG AND CHAMPLAIN RAILROAD.**—A public meeting was held at Plattsburgh on the 8th inst., at which, among other things, it was resolved that the construction of a railroad from Ogdensburg to Lake Champlain, by the State, "can no longer be delayed, without an abandonment of the best interests of northern New York," and the members of the Legislature from the 4th Senate district are requested to urge the immediate passage of a law authorizing the commencement of the work.—*New York Standard*.

TO OUR READERS.

We have received another communication on Mr. Ellet's pamphlet on the "Failure of many Railroads," etc., too late for our present number, but will appear in our next.